(Draft-March, 2001)

# Appendix C

## Middle Rio Grande Valley Model Calibration and Validation

The calibration and validation procedures described here are for the Middle Rio Grande Valley, Cochiti Reservoir to San Marcial (URGWOM model version 1.4). The purpose of these procedures is to produce the best match between modeled flows and historical flows, and to describe the error between modeled flow and historical flow.

### Calibration

The period of record selected to calibrate the model was whole months with no precipitation, or only trace precipitation, between January 1, 1985 and December 31, 1997. The reason for picking whole months with no precipitation is because this is when the model should be most accurate. Significant precipitation would cause model error resulting from ungaged tributary and overland flow in the reaches. Tributaries that are gaged and included in the model are Galisteo River, Jemez River, North Floodway Channel, South Diversion Channel, and Rio Puerco. There are numerous ephemeral channels that flow intermittently in response to precipitation and groundwater drainage, but that are not included in the model. The stated criteria resulted in the following months of record for model calibration: April 1989, June 1989, November 1989, April 1991, April 1993, October 1995, March 1996, April 1996, May 1996 and December 1996. These months gave a total of 304 calibration days.

The objective of the calibration procedure was to modify model parameters so as to minimize the difference between measured historical flow and modeled flow. The calibrated model should not bias modeled flow to either underestimate or overestimate when compared to historical flow. The objective was met by optimizing daily return flow volume for each modeled reach: Cochiti to San Felipe, San Felipe to Albuquerque, Albuquerque to Bernardo, Bernardo to San Acacia, and San Acacia to San Marcial. Figure 1 is an example from the RiverWare workspace including the model objects used to make calibration adjustments in the San Felipe to Albuquerque reach.

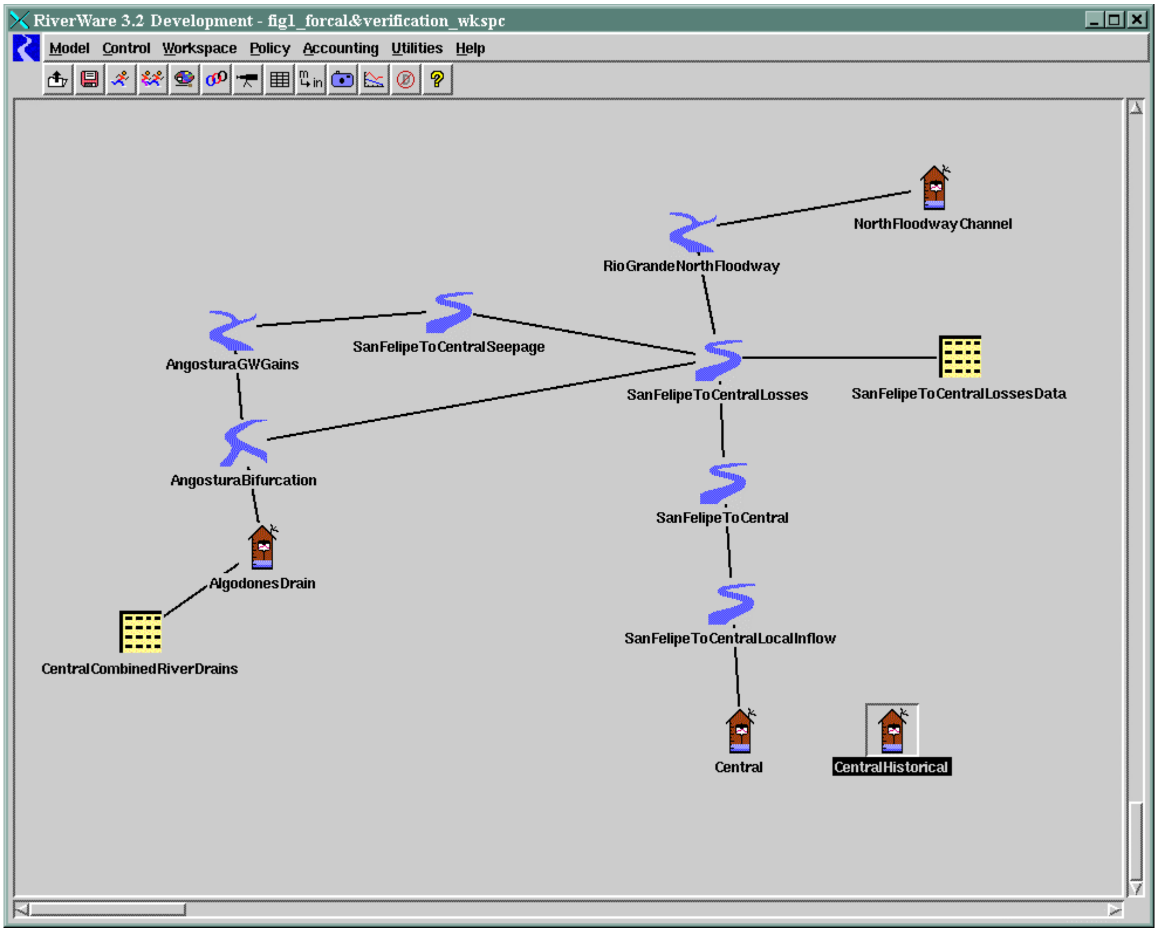


Figure 1. Example segment from the San Felipe to Albuquerque reach including RiverWare workspace objects used to make calibration adjustments.

Using the San Felipe to Albuquerque reach as an example, the optimization procedure consisted of changing the value of the “Variable GainLoss Coeff Table” slot of the “SanFelipeToCentralSeepage” reach object. The value in the “Variable GainLoss Coeff Table” slot affects the quantity of river leakage that is passed from the “SanFelipeToCentralLosses” reach object to the “AngosturaGWGains” reach object. Modelers changed the value until the volume of the water returning to the “SanFelipeToCentralLosses” reach object through the “AngosturaBifurcation” object caused the modeled flow volume at the “Central” stream-gage object to match the historical flow volume at the “CentralHistorical” stream-gage object. In other words, the value of the “Variable GainLoss Coeff Table” slot was adjusted until the sum of the differences between historical flow and modeled flow was about zero. The table below gives the optimized value for the “Variable GainLoss Coeff Table” slot for the 5 middle valley reaches.

| Reach | Optimized value for "Variable GainLoss Coeff Table" slot of reach object |
|---|---|
| Cochiti to San Felipe | -1.85 |
| San Felipe to Albuquerque | 0.046 |
| Albuquerque to Bernardo | -0.287 |
| Bernardo to San Acacia | 0.08 |
| San Acacia to San Marcial | -0.06 |

The positive and negative sign of the optimized value given above, and its use in the model, can be confusing. The optimization procedure takes the river leakage, and applies a multiplier that affects the proportion of river leakage intercepted by the drains. A streamflow gage located on the drain determines the measured, historical flow in the drain and returns the excess to the river as “return flow”. Modelers used a two-day lag in movement of water from the river to the drain in the two reaches, Bernardo to San Acacia and San Acacia to San Marcial. No time lag was used in the other reaches. The following table gives further clarification of the optimized value used above:

| Reach | Optimized drain interception (expressed as % of river leakage) |
|---|---|
| Cochiti to San Felipe | No river leakage is intercepted; and 85% of the river leakage value is subtracted from drain flow. |
| San Felipe to Albuquerque | 104.6% of river leakage value is intercepted by drain |
| Albuquerque to Bernardo | 71.3% of river leakage value is intercepted by drain |
| Bernardo to San Acacia | 108% of river leakage value is intercepted by drain |
| San Acacia to San Marcial | 94% of river leakage value is intercepted by drain |

In the Cochiti to San Felipe reach, none of the river leakage was intercepted and 85 percent of the river leakage value needed to be subtracted from the drain flow in order to optimize return flow. In two reaches, San Felipe to Albuquerque and Bernardo to San Acacia, more than 100 percent of the river leakage was needed to optimize return flow. In the reaches, Albuquerque to Bernardo and San Acacia to San Marcial, a portion but not all of the river leakage was needed to optimize return flow.

The modeled situations of river, drain, and return flow interactions are a simplification and the actual hydrology is complex and different. Groundwater table processes within the middle Rio Grande Valley are complex and affected by drains, canals, acequias, laterals, turnouts, and return-flow wasteways on both the east and west side of the Rio Grande. The model simplifies this flow system to a river channel for the Rio Grande and one parallel channel to the west of the Rio Grande for combined drain flow from Cochiti to San Acacia. From San Acacia to San Marcial the model has a river channel and two parallel channels to the west. The innermost channel to the west represents the Low-

Flow Conveyance Channel. The outermost channel represents the Socorro Main Canal. One obvious difference between the model and the actual hydrologic processes is that the drains intercept groundwater flow, not only, from the river, but also, from the side of the drain away from the river.

## Validation

The validation procedure describes the error between modeled flow and historical flow. One validation procedure would consist of selecting monthly periods of record between January 1, 1998 and September 30, 1999 with no precipitation. Under ideal circumstances, modeled flow would match historical flow for these periods of no precipitation. The URGWOM team decided to include all periods of record that were available from January 1, 1985 through September 30, 1999; regardless of whether there was precipitation or not. This gives a total of 5383 validation days and includes the 304 days that were used for calibration. Therefore, the error between the historical and modeled flow includes error introduced by precipitation and flow in ungaged channels, and measurement errors in the data used in the model.

Errors can be determined independently for each reach. In this case, the model is run using known historical inflow at the upstream end of the reach, allowing the model to predict flow at the downstream end of the reach. Modelers determined error by comparing historical flow at the downstream end of the reach with modeled flow at the downstream end of each reach. Figures 2 through 6 show the historical and modeled flow for each reach. For the reach starting below Cochiti Reservoir and ending at San Felipe, mean-daily-modeled flow (1675 cubic feet per second (cfs)), averaged over the 5381 days of record used to compute statistics, is 50 cfs less than mean-daily-measured-historical flow (1725 cfs) (fig. 2). Likewise, for the reach from San Felipe to Central Avenue, Albuquerque, mean-daily-modeled flow (1607 cfs) is 14 cfs more than mean-daily-measured-historical flow (1593 cfs) (fig. 3). For the third reach, Central Avenue, Albuquerque to Bernardo, mean-daily-modeled flow (1328 cfs) is 113 cfs less than mean-daily-measured-historical flow (1441 cfs) (fig. 4). For the fourth reach, Bernardo to San Acacia, mean-daily-modeled flow (1466 cfs), is 6 cfs less than mean-daily-measured-historical flow (1472 cfs) (fig. 5). In the last reach, San Acacia to San Marcial, mean-daily-modeled flow (1120 cfs), is 45 cfs less than mean-daily-measured-historical flow (1165 cfs) (fig. 6). A histogram showing the number of days that modeled flow is within a selected range of difference from historical flow is given in figure 7. From this histogram it can be seen that modeled flow is within plus or minus 100 cubic feet per second of historical flow, 2121 days of the total 5381 days tested (39% of the time).

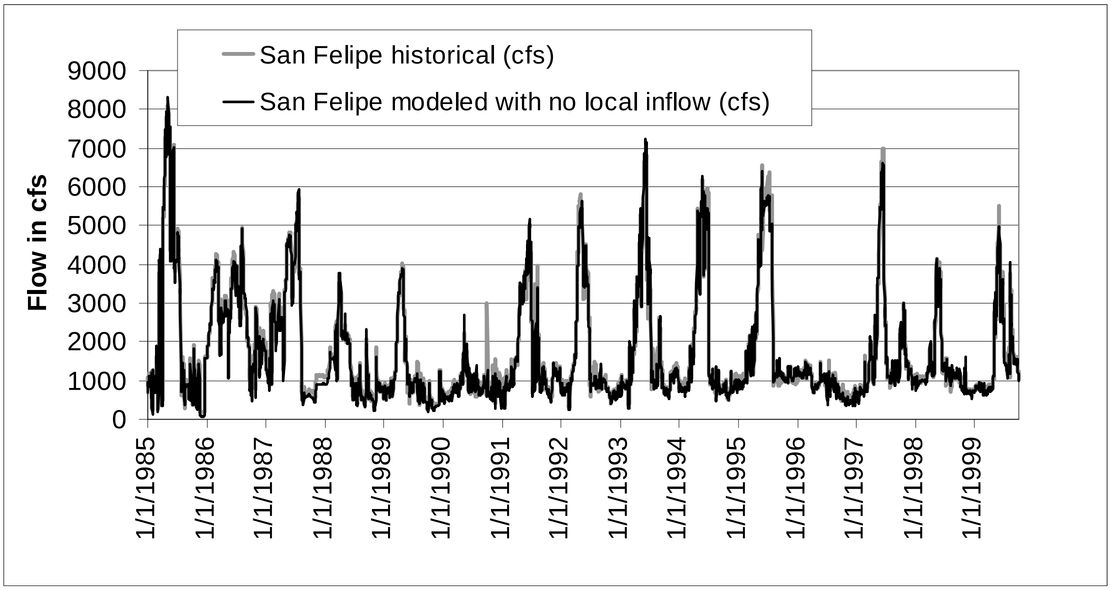


Figure 2. Mean-daily-modeled flow and mean-daily-measured-historical flow, from below Cochiti Reservoir to San Felipe for the period of record, January 1, 1985 through September 30, 1999.

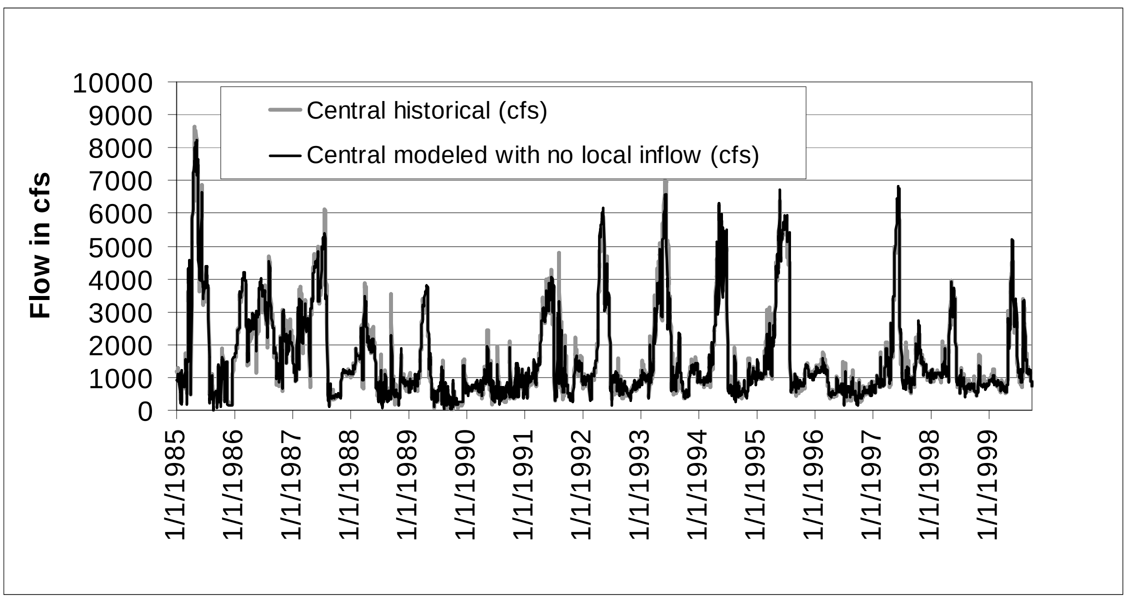


Figure 3. Mean-daily-modeled flow and mean-daily-measured-historical flow, from San Felipe to Central Avenue, Albuquerque for the period of record, January 1, 1985 through September 30, 1999.

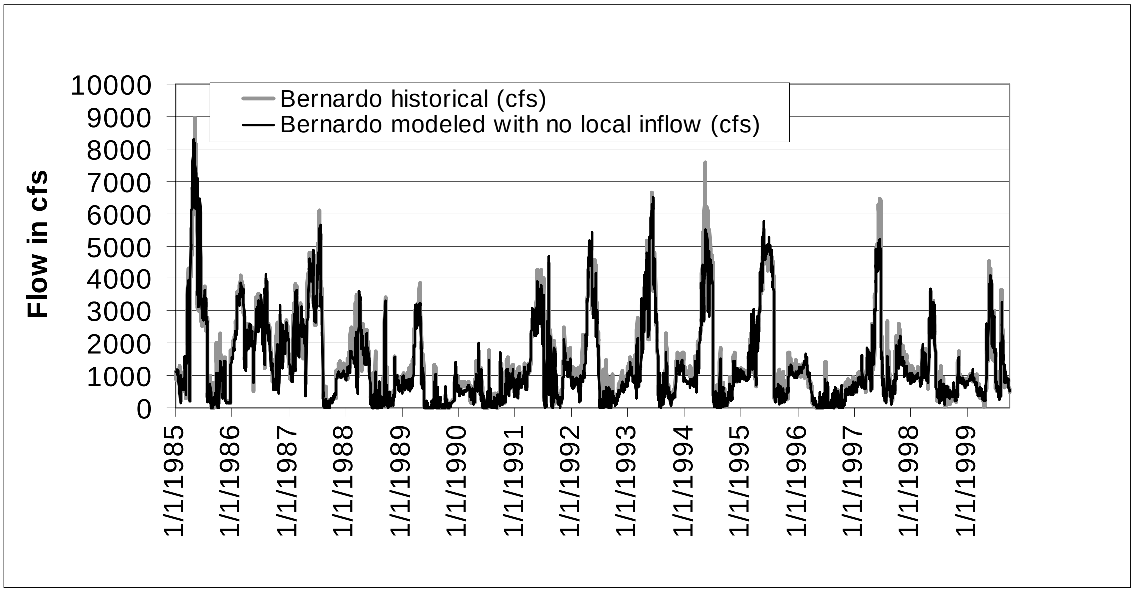


Figure 4. Mean-daily-modeled flow and mean-daily-measured-historical flow, from Central Avenue, Albuquerque to Bernardo for the period of record, January 1, 1985 through September 30, 1999.

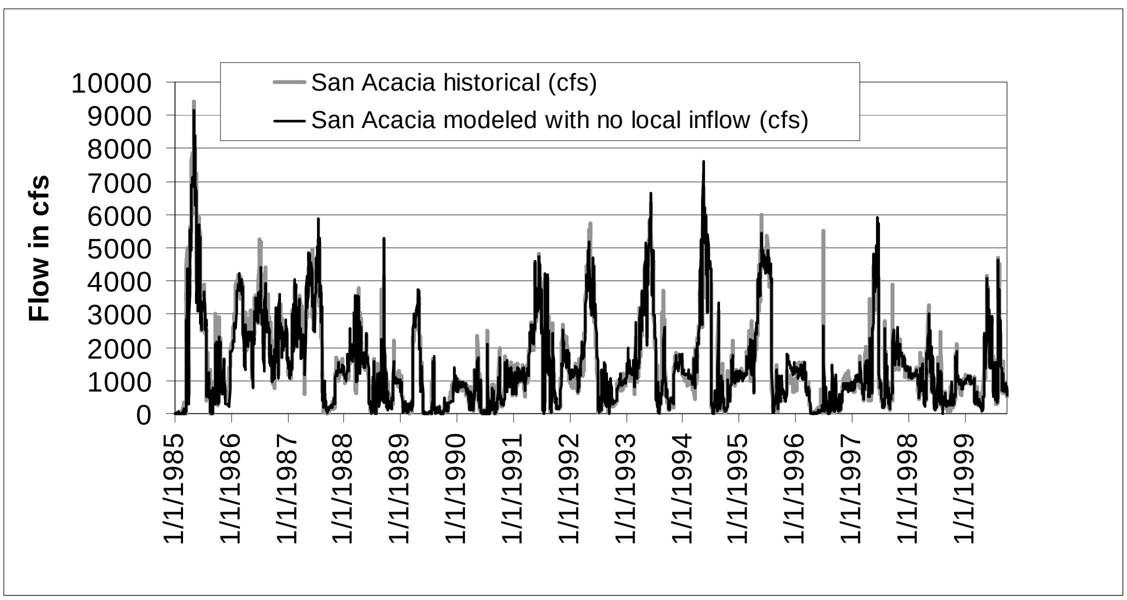


Figure 5. Mean-daily-modeled flow and mean-daily-measured-historical flow, from Bernardo to San Acacia for the period of record, January 1, 1985 through September 30, 1999.

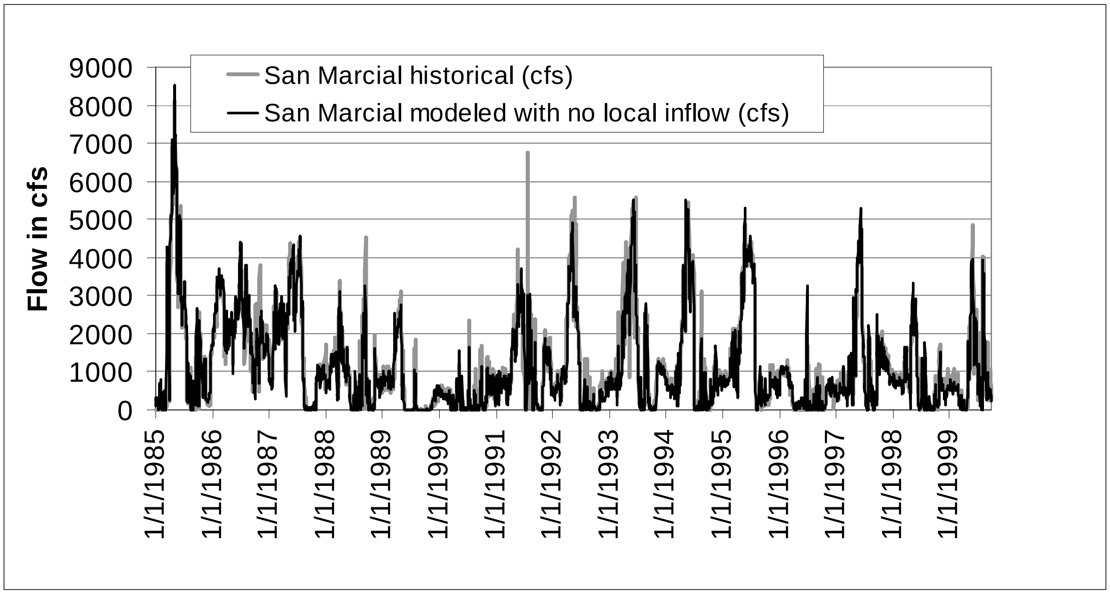


Figure 6. Mean-daily-modeled flow and mean-daily-measured-historical flow, from San Acacia to San Marcial for the period of record, January 1, 1985 through September 30, 1999.

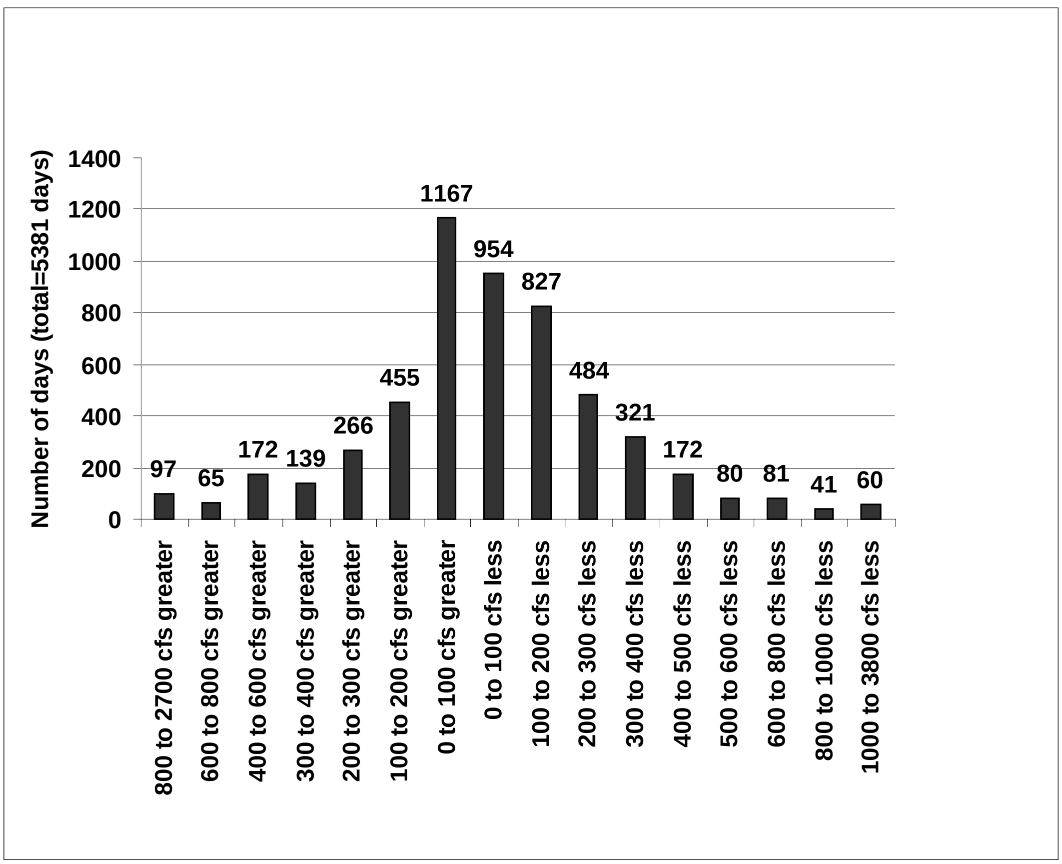


Figure 7. Number of days that modeled flow from San Acacia to San Marcial is a selected range greater or less than measured historical flow at San Marcial.

Errors can be determined cumulatively from Cochiti Reservoir to San Marcial. In this case, the model errors are accumulated. The model is run using historical outflow from Cochiti Reservoir at the upstream end of the reach, and allowed to predict flow at each downstream gage, San Felipe, Central Avenue, Bernardo, San Acacia and San Marcial. Modeled flow at gages is not allowed to go below zero, although there are days when predicted losses in the model would drive the flow below zero. Figure 8 shows the historical and modeled flow for the reach from Cochiti to San Marcial. Mean-daily-modeled flow (974 cfs), averaged over the 5381 days of record, is 191 cfs less than mean-daily-measured-historical flow. A histogram showing the number of days that modeled flow is within a selected range of difference from historical flow is given in figure 9. From this histogram it can be seen that modeled flow is within plus or minus 100 cubic feet per second of historical flow 1357 days of the total 5381 days tested (25% of the time).

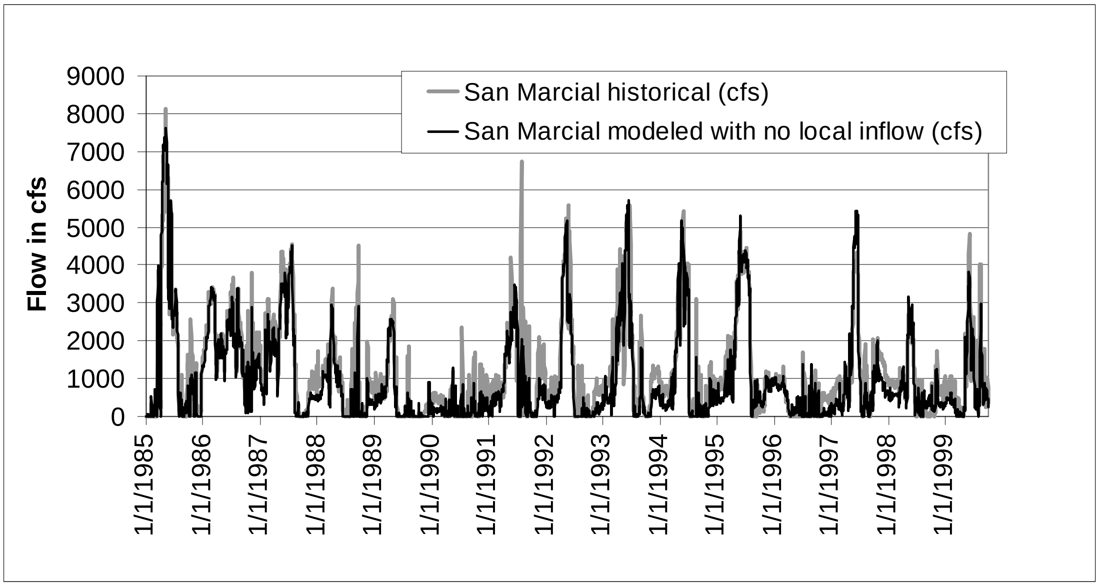


Figure 8. Mean-daily-modeled flow and mean-daily-measured-historical flow, from below Cochiti Reservoir to San Marcial for the period of record, January 1, 1985 through September 30, 1999.

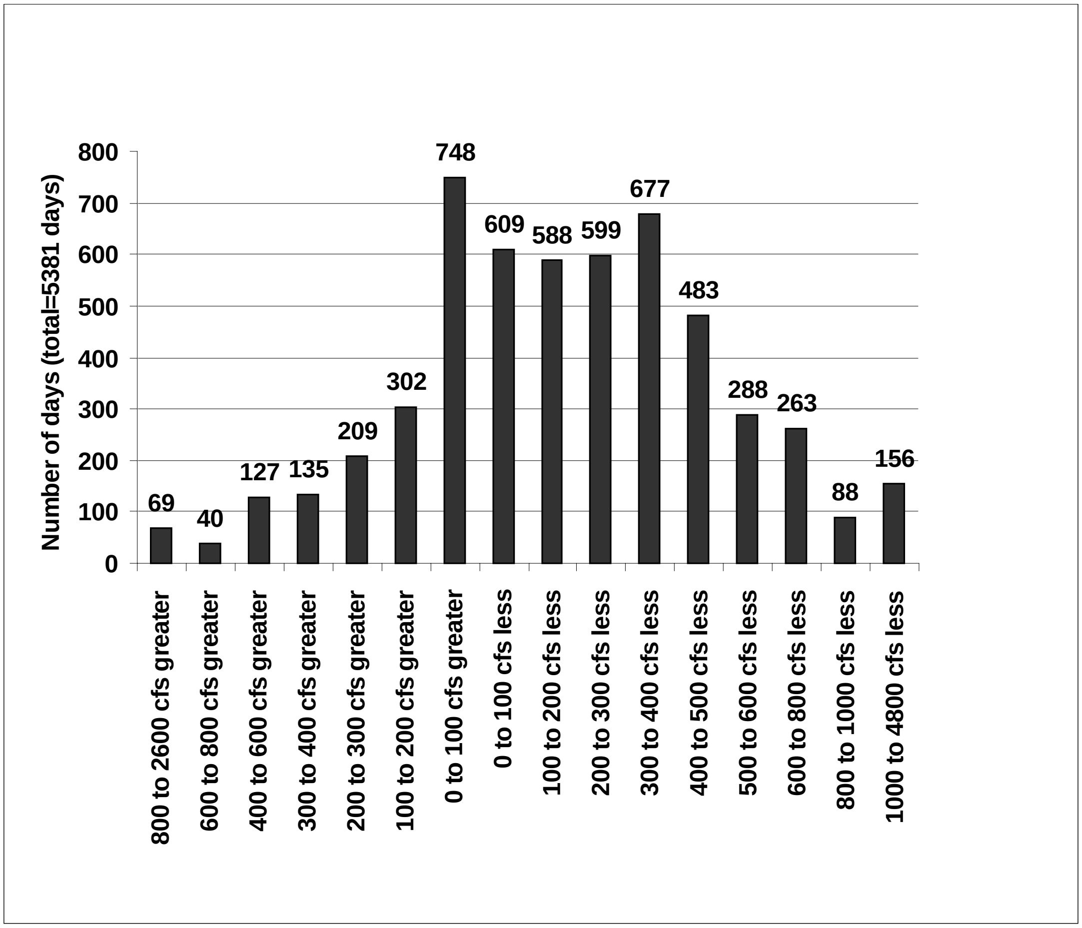


Figure 9. Number of days that modeled flow from Cochiti to San Marcial is within a selected range greater or less than measured historical flow at San Marcial.